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PATENT ABSTRACTS OF JAPAN

(11)Publication number : **11-213419**

(43)Date of publication of application : **06.08.1999**

(51)Int.Cl. **G11B 7/12**
G11B 7/085
G11B 7/135

(21)Application number : **10-016848**

(22)Date of filing : **29.01.1998**

(71)Applicant : **NIKON CORP**

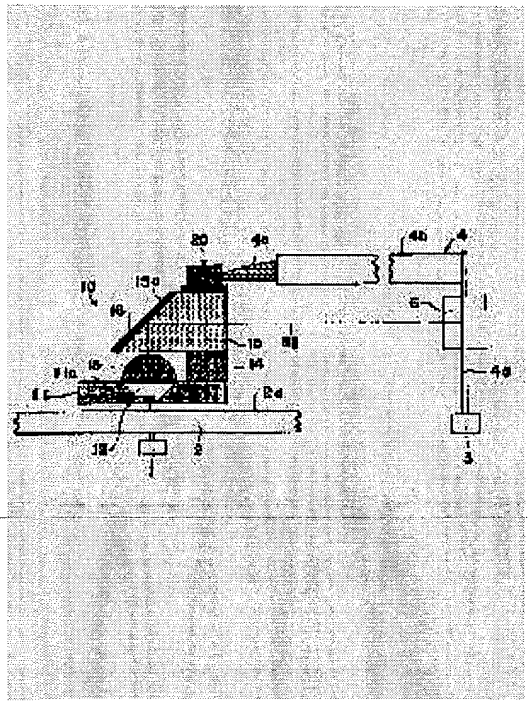
(72)Inventor : **IRITA TAKESHI**

(54) OPTICAL HEAD, AND OPTICAL RECORDING AND REPRODUCING DEVICE

(57)Abstract:

PROBLEM TO BE SOLVED: To perform the tracking operation control of an optical recording and reproducing device enabling a high density recording and reproduction by using a slider type head on which a solid-state immersion lens is mounted with high accuracy.

SOLUTION: This optical head 10 is constituted by arranging a solid-state immersion lens 12 at the position near the recording surface 2a of the upper surface of an optical magnetic disk 2 in a slider 11 which is placed on the recording surface 2a of the upper surface of the optical magnetic head 2 rotated by a spindle motor 1 and positioned by being floated by an air bearing from the recording surface 2a and arranging an objective lens 13 for converging a recording and reproducing light on the lens 12 at the upper side of the lens 12. Also, the optical head 20 is held to a head arm 4 with a fine moving actuator 20, and a highly accurate tracking control is performed by the control of the fine moving actuator 20 in addition to the rotational control of the head arm 4 by a voice coil motor 3.



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[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

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CLAIMS

[Claim(s)]
[Claim 1] The slider which is put on the recording surface of the optical recording medium which carries out flat-surface movement, surfaces from this recording surface by air bearing, and is located, The solid immersion lens arranged in the location close to the recording surface of said optical recording medium in this slider, The objective lens which it is arranged [objective lens] in said solid immersion lens bottom in said slider, and makes said solid immersion lens condense record playback light, The optical head characterized by coming to have the jogging actuator which it is arranged [actuator] between the head arm which holds said slider and carries out flat-surface migration, and said slider, and makes the minute migration of said slider carry out in the flat-surface migration direction to said head arm.
[Claim 2] The optical head according to claim 1 to which the part which forms the optical path for said record playback light which is condensed by said solid immersion lens through said objective lens, and results in said optical recording medium in said slider is characterized by having light transmission nature to said record playback light.
[Claim 3] Claim 1 characterized by preparing the optical mirror for leading said record playback light irradiated from the outside to said objective lens in said slider, or an optical head given in 2.
[Claim 4] The optical head according to claim 3 characterized by for said optical mirror giving the reflective film to an optical prism, and constituting it.
[Claim 5] The optical head according to claim 1 to 4 characterized by it being possible for coiled form conductive wiring to be prepared in the location which counters said optical recording medium in said slider, and to make this conductive wiring perform the field modulation of said optical recording medium.
[Claim 6] The optical head according to claim 1 to 5 characterized by said jogging actuator being an actuator using either an electrostatic-force drive, a piezo-electric force drive and an electromagnetic-force drive.
[Claim 7] The optical record regenerative apparatus characterized by coming to have the medium drive which holds an optical recording medium and carries out flat-surface movement, an optical head according to claim 1 to 6, a head arm holding this optical head, and the arm drive that drives said head arm so that said optical head may be moved in the flat-surface movement direction of said optical recording medium, and the crossing direction.
[Claim 8] The optical record regenerative apparatus according to claim 7 characterized by holding two or more optical recording media by said medium drive, and having said two or more optical heads corresponding to each [these] optical recording medium.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the optical record regenerative apparatus which carries out record playback of the information optically, and the optical head used for this optical record regenerative apparatus.
[0002]
[Description of the Prior Art] In recent years, the recording method which makes effectual numerical aperture of optical system one or more using a solid immersion lens (called a solid emersion lens or SIL) in the equipment which records or reproduces information optically or a system especially a magneto-optic-recording regenerative apparatus, or a system for the purpose of raising recording density is proposed. for example, example of an experiment which carried the solid immersion lens on the flying head of a magneto-optic disk B.D.Terris ** -- Applied Physics Letter 68 (2) and 141-143 (1996) It is shown. A part for the point of that head is shown in drawing 7 , and a solid immersion lens 92 is carried on the slider 91 which surfaces by air bearing, and this head 90 arranges the objective lens 93 which carries out convergence incidence of the beam of light to a solid immersion lens 92 in the upper part of a solid immersion lens 92, and is constituted.
[0003] With such a configuration, since the distance of a solid immersion lens 92 and a record medium 95 is decided by balance with slider structure, its load, and the surfacing force by the air bearing generated with rotation of a record medium and it always becomes a fixed distance, a focus servo device is unnecessary. In the case of the optical recording regenerative apparatus using such a head, the rotation drive of the voice coil motor which attached this head at the tip of a head arm, and was formed in the origin of this arm performs record playback moving a head to radial [over rotation of a record medium] (surface of revolution a hand of cut and direction which crosses inside), i.e., by making tracking actuation perform, (scan).
[0004]
[Problem(s) to be Solved by the Invention] However, with the equipment used from such the former, since control of tracking actuation is based only on the roll control of the voice coil motor formed in the origin of a head, it has the problem that fine tracking motion control is difficult. Although record of a fine pitch from which a track pitch is set to 1 micrometer or less will also become possible recently especially if the slider mold head in which high density record playback was required and the above solid immersion lenses were carried is used, there is a problem that it is difficult to perform tracking actuation with high precision to such a fine track pitch.
[0005] This invention is what took the example by such situation, and it aims at offering the optical head which can perform tracking motion control with high degree of accuracy in the optical record regenerative apparatus in which high density record playback is possible using the slider mold head in which the solid immersion lens was carried, and an optical record regenerative apparatus.
[0006]
[Means for Solving the Problem and its Function] It sets to this invention for such purpose achievement.

The recording surface of the optical recording medium (for example, optical disk) which carries out flat-surface movement (usually) To the slider which is put on the top face or front face of a disk, surfaces from this recording surface by air bearing, and is located A solid immersion lens is arranged in the location close to the recording surface of an optical recording medium, the objective lens which makes the bottom condense record playback light to a solid immersion lens is arranged, and an optical head is constituted, and further, it is constituted so that a slider may be made to hold to a head arm through a jogging actuator.

[0007] In performing optical recording playback using the optical head of such a configuration, where flat-surface movement (for example, rotation) of the optical recording medium (magneto-optic disk) is carried out, it places the slider held at the head arm on the recording surface of an optical recording medium. At this time, it will be in the condition of the slider having maintained a fixed distance from the recording surface of an optical recording medium according to the air bearing effectiveness produced by the relative motion of a slider and an optical recording medium, and having floated. And record playback light is irradiated through an objective lens at a solid immersion lens from the exterior. At this time, it is condensed by the objective lens, record playback light is led to a solid immersion lens, a condensing spot is formed in an optical recording medium, and informational record playback is performed using this condensing spot. since the size of this condensing spot will be set to 1/n compared with the case where there is no solid immersion lens if the refractive index of a solid immersion lens is set to n, informational record playback is possible by the condensing, very small spot -- becoming -- **** -- the high density record playback by the thin track pitch is attained. In addition, even if it does not use a focusing device, a condensing spot can be made to always form in the recording surface of an optical recording medium, since it will be in the condition that always maintained a fixed distance by air bearing, and the slider surfaced.

[0008] by the way -- such -- **** -- when making the high density in a thin track pitch perform, it is necessary to perform very highly precise tracking migration control corresponding to this track pitch When using the optical head of this invention, the rotation drive of the head arm holding this optical head is carried out with a voice coil motor etc., fundamental tracking migration control is performed, and fine tracking migration control is further performed by the jogging actuator. for this reason, the thing for which difficult fine tracking migration control is compensated with rotation drive control of a voice coil motor etc. with a jogging actuator -- possible -- **** -- it is possible to perform correctly high density record playback by the thin track pitch.

[0009] In addition, in the slider which constitutes the optical head concerning this invention, the part which forms the optical path for record playback light which is condensed by the solid immersion lens through an objective lens, and results in an optical recording medium needs to have light transmission nature to record playback light, and it is formed as this part in a slider is an opening, or for this reason, it is formed from a transparent material.

[0010] Moreover, it is desirable to prepare the optical mirror for leading the record playback light irradiated from the outside to an objective lens with the optical head concerning this invention in a slider. At this time, in an optical prism, the reflective film can be given and an optical mirror can be constituted.

[0011] Furthermore, with the optical head concerning this invention, coiled form conductive wiring is prepared in the location which counters the optical recording medium in a slider, it is desirable to enable it to make this conductive wiring perform the field modulation of an optical recording medium, and it becomes possible [an over-write / record / this].

[0012] In addition, the jogging actuator which constitutes the optical head concerning this invention can consist of actuators which use either an electrostatic-force drive, a piezo-electric force drive and an electromagnetic-force drive.

[0013] The optical record regenerative apparatus concerning this invention is constituted using the optical head concerning above this inventions. The medium drive which holds an optical recording medium and carries out flat-surface movement (for example, spindle motor 1 made to rotate the magneto-optic disk 2 in an operation gestalt), It has a head arm holding this optical head, and the arm

drive (for example, voice coil motor 3 in an operation gestalt) which drives a head arm so that an optical head may be moved in the flat-surface movement direction of an optical recording medium, and the crossing direction, and is constituted. In addition, you may constitute so that two or more optical recording media may be held with a medium drive, and at this time, two or more optical heads are arranged corresponding to each optical recording medium, and an optical record regenerative apparatus is constituted.

[0014] In this optical record regenerative apparatus, the rotation drive of the head arm holding an optical head is carried out with an arm drive, fundamental tracking migration control is performed, and a jogging actuator performs fine tracking migration control further. for this reason, the thing for which difficult fine tracking migration control is compensated with rotation drive control of a voice coil motor with a jogging actuator -- possible -- **** -- it is possible to perform correctly high density record playback by the thin track pitch.

[0015]

[Embodiment of the Invention] Hereafter, the desirable operation gestalt of this invention is explained with reference to a drawing. The optical record regenerative apparatus as the 1st operation gestalt of this invention is shown in drawing 1 and drawing 2 . This equipment The optical head 10 approached and located on top-face recording surface 2a of the magneto-optic disk 2 by which a rotation drive is carried out with a spindle motor 1, It has the head arm 4 holding this optical head 10, the voice coil motor 3 for rotating this head arm 4, and optical irradiation equipment 5 that irradiates record playback laser light, and is constituted.

[0016] The optical head 10 is equipped with the slider 11, and a slider 11 is located on top-face recording surface 2a of the rotating magneto-optic disk 2, and will be in the condition that only regularity minute distance surfaced from top-face recording surface 2a according to the air bearing effectiveness (that is, a flying head is constituted). A head arm 4 consists of suspension section 4c which supports it in the tip of arm section 4b prolonged horizontally and arm section 4b from the upper limit of revolving-shaft 4a by which is connected with a voice coil motor 3 and a rotation drive is carried out, and this revolving-shaft 4a as permits migration of the upper and lower sides of the optical head 10. If the rotation drive of the revolving-shaft 4a is carried out by the voice coil motor 3, rocking migration of the arm section 4b will be carried out horizontally, the optical head 10 is mostly moved in the direction of a right angle (the direction of arrow-head A in drawing 2) to the hand of cut of a magneto-optic disk 2, and the optical head 10 is scanned on top-face recording surface 2a of a magneto-optic disk 2. That is, tracking control is performed by the voice coil motor 3.

[0017] In the optical head 10, opening 11a of the shape of a circular taper which spreads up to a slider 11 is formed, a solid immersion lens 12 is arranged by the lower part of opening 11a, and the objective lens 13 is arranged in the upper part. On a slider 11, the micro prism 15 is arranged through a spacer 14, and the high reflective film 16 is formed in reflector 15a. This micro prism 15 is connected with suspension section 4c of a head arm 4 through the jogging actuator 20. In addition, this opening 11a may be made full of the ingredient which has transparence or light transmission nature.

[0018] This jogging actuator 20 is expanded to drawing 3 , and is shown, and it consists of an parallel monotonous mold jogging actuator made from silicon. It has the fixed block 23 and the movable block 24 which were specifically formed in the 1st substrate 21 joined to suspension section 4c, and is constituted, and both blocks 23 and 24 have the parallel plate of a large number which are prolonged in parallel mutually and counter. Use electrostatic force, the movable block 24 is made to move slightly in an parallel plate and the right-angled direction (the direction of arrow-head B) to a fixed block 23, and it has come to be able to perform thin kana and highly precise migration control by carrying out the seal of approval of the electrical potential difference among these parallel plates.

[0019] That is, this jogging actuator is an actuator of an electrostatic-force drive mold. It is joined to the micro prism 13, and if the movable block 24 carries out the seal of approval of the electrical potential difference between parallel plates and the movable block 24 is made to move slightly for this reason, it can make the optical head 10 move slightly in the direction of arrow-head B to suspension section 4c further. In addition, this direction of arrow-head B is the same direction as the migration direction A for

the scan of the optical head 10 by the voice coil motor 3.
[0020] Optical irradiation equipment 5 is countered aslant at revolving-shaft 4a of a head arm 4, the reflective mirror 6 is arranged, it is reflected by the reflective mirror 6 and the record playback laser light irradiated from optical irradiation equipment 5 is led to the micro prism 15, as the chain lines R1 and R2 show to drawing 1 and drawing 2 . Thus, after the record playback laser light led to the micro prism 15 is reflected by the high reflective film 16 of reflector 15a of the micro prism 15, it is condensed with an objective lens 13, incidence is carried out to a solid immersion lens 12, and a ********** condensing spot is formed in top-face recording surface 2a of a magneto-optic disk 2 by the solid immersion lens 12.
[0021] Actuation of the optical record regenerative apparatus of the above configurations is explained. A magneto-optic disk 2 is first rotated at the rate of predetermined with a spindle motor 1. At this time, the optical head 10 which was supported by suspension section 4c of a head arm 4, and has been arranged on top-face recording surface 2a of a disk 2 will be in the condition that the slider 11 surfaced only in top-face recording surface 2a to minute distance, according to the air bearing effectiveness. In this condition, as record playback laser light is irradiated from optical irradiation equipment 5 and the chain lines R1 and R2 show, it is reflected by the reflective mirror 6 and incidence is carried out to the micro prism 15. And it is reflected by reflector 15a of the micro prism 15, and is condensed with an objective lens 13, and incidence is carried out to a solid immersion lens 12, it converges on it, and a condensing spot is formed in top-face recording surface 2a of a magneto-optic disk 2.
[0022] The magneto-optic disk 2 is driven by fixed-speed rotation, the flying height of a slider 1 is always fixed, and it is set up here so that it may become the same as that of the distance to a condensing spot from a solid immersion lens 12. For this reason, it is possible to make a condensing spot always form in top-face recording surface 2a of a magneto-optic disk 2, and it is not necessary to establish a focusing device like before.
[0023] Thus, when recording information by the condensing spot light formed, the condensing spot section is first heated by the laser light irradiated here more than Curie temperature, the magnetism of this part is changed by the field impressed from the exterior, information record is performed, but since it is the thing of already the common knowledge about this, the equipment which impresses a field is not illustrated but also omits that actuation explanation. Moreover, the equipment which detects a magnetooptic Kerr effect is used about informational playback (reading), and illustration and its explanation are omitted also about this.
[0024] Such record playback is performed by moving the optical head 10 to radial [of a magneto-optic disk 2] corresponding to rotation of a magneto-optic disk 2 (scanning), a head arm 4 is rotated with the voice coil motor 3 arranged at the origin of a head arm 4, a scan, i.e., the tracking, of this optical head 10, and it is performed. however, a voice coil motor 3 is used as a coarse adjustment servo here -- having -- a head arm 4 -- control of a low-speed component is managed comparatively. That is, there is a limitation in the control precision of the tracking by the voice coil motor 3, since fine tracking control is difficult, this is used for coarse adjustment servo control, and coarse adjustment servo control performs control of the minute and high-speed component which it cannot finish following by applying a jogging servo with the jogging actuator 20. Thereby, the optical recording playback by super-high density is attained.
[0025] namely, **** by the jogging actuator 20 while forming a ********** condensing spot using a solid immersion lens 12 according to this equipment -- photo-regenerating record by super-high density is enabled by performing fine tracking control.
[0026] Next, the operation gestalt from which this invention differs is explained with reference to drawing 4 . About the spindle motor 1 which carries out the rotation drive of the magneto-optic disk 2, the voice coil motor 3 made to rotate head arm 4', the optical irradiation equipment 5 (not shown to drawing 4) which irradiates record playback laser light, and the reflective mirror 6, since the optical record regenerative apparatus shown in this drawing is the same as that of the thing of the equipment shown in drawing 1 and drawing 2 , it attaches the same number and omits that explanation.
[0027] In this equipment, the optical head 50 is supported by head arm 4' through suspension equipment

8 and the jogging actuator 60. Head arm 4' consists of revolving-shaft 4a' by which a rotation drive is carried out with a voice coil motor 3, and arm section 4b' horizontally prolonged from the upper limit of this revolving-shaft 4a', the jogging actuator 60 is attached at the tip of arm section 4b', and the optical head 50 is supported through suspension equipment 8 at the tip side of the jogging actuator 60.
[0028] The slider 51 which surfaces by air bearing when a magneto-optic disk 2 rotates the optical head 50, The solid immersion lens 52 arranged at the lower part in the opening 11 formed in the slider 51 in the shape of [which spreads up] a circular taper, It consists of an objective lens 53 which countered the upper part of an opening 11 with the solid immersion lens 12, and was arranged in it, and a micro mirror (optical mirror) 55 with the mirror side 56 which consists of a high reflective membrane layer, and the micro mirror 55 is supported by suspension equipment 8. In addition, it may be filled up with the ingredient which has transparence or light transmission nature in the opening of a slider 51, and a slider may be constituted. Moreover, the micro mirror 55 may consist of same ingredients as a slider.
[0029] Furthermore, in this optical head 50, the micro coil 57 equipped with the coiled form conductive wiring 58 as shown in the base side of a slider 51 at drawing 5 is embedded. By energizing to this wiring 58, it is possible an over-write [perform the field modulation of the part which the micro coil 57 in top-face recording surface 2a of a magneto-optic disk 2 counters, and / record].
[0030] The jogging actuator 60 consists of an electrostrictive actuator (piezo-electric force drive mold actuator) which comes to connect the laminating mold piezoelectric device 63 with illustration between a fixed block 61 and the movable block 62 like. A fixed block 61 is connected with arm section 4b[of head arm 4']', and the movable block 62 has led to suspension equipment 8, and it can perform control which makes the minute migration of the movable block 62 carry out in the direction of arrow-head B to a fixed block 61 with high degree of accuracy by energization control to a piezoelectric device 63.
[0031] Actuation of the optical record regenerative apparatus of the above configurations is explained. The optical head 50 which was supported by head arm 4' through rotation **** and suspension equipment 8 at the rate of predetermined with the spindle motor 1 in the magneto-optic disk 2, and has been arranged on top-face recording surface 2a of a disk 2 will be in the condition that top-face recording surface 2a surfaced [the slider 51] only in minute distance, according to the air bearing effectiveness. In this condition, record playback laser light is irradiated from optical irradiation equipment 5, it is reflected by the reflective mirror 6, and incidence is carried out to the micro mirror 55. And it is reflected in respect of [56] the mirror of the micro mirror 55, and is condensed with an objective lens 53, and incidence is carried out to a solid immersion lens 52, it converges on it, and a condensing spot is formed in top-face recording surface 2a of a magneto-optic disk 2.
[0032] As mentioned above, the magneto-optic disk 2 is driven by fixed-speed rotation, the flying height of a slider 1 is always fixed, it is set up so that the distance to a condensing spot may become the same as that of this flying height from a solid immersion lens 12, and he is trying to make a condensing spot always form in top-face recording surface 2a of a magneto-optic disk 2, without using a focusing device. And informational record playback is performed by the condensing spot light formed in this way.
[0033] On the occasion of such record playback, control which makes radial [of a magneto-optic disk 2] scan the optical head 50 corresponding to rotation of a magneto-optic disk 2 (tracking) is performed by rotating head arm 4' with a voice coil motor 3. However, a voice coil motor 3 is used as a coarse adjustment servo also here, and control of the minute and high-speed component which is made to control a low-speed component comparatively and it cannot finish following in coarse adjustment servo control of a head arm 4 is performed by applying a jogging servo with the jogging actuator 60. Thereby, the optical recording playback by super-high density is attained.
[0034] In addition, it is possible by forming the micro coil 57 in the base of a slider 51, and energizing to that conductive wiring 58 with this optical record regenerative apparatus, an over-write [perform the field modulation of the part which the micro coil 57 in top-face recording surface 2a of a magneto-optic disk 2 counters, and / record].
[0035] In the above example, although the voice coil motor which is a rotary actuator is used for rotation control of a head arm, you may constitute so that a linear mold actuator may perform the rotation drive of a head arm. Moreover, a jogging actuator may be constituted using the actuator not only by an

electrostatic type or a piezo-electric mold actuator but electromagnetic force. Moreover, an optical recording medium is not restricted to the above-mentioned magneto-optic disk, and contains all media that perform record playback using light, such as an optical disk.

[0036] Furthermore, it is possible in the whole optical head a miniaturization, thin shape-ization, and to lightweight-ize with the optical head configuration concerning this invention as shown in the above example. For this reason, laminating arrangement of this optical head can be carried out into the same case, and a small optical record regenerative apparatus can also consist of a magneto-optic disk and a multi-platter mold which has two or more optical heads.

[0037]

[Effect of the Invention] As explained above, according to this invention, it becomes possible to perform highly precise tracking control using the small lightweight optical head which carried the solid immersion lens in the slider, and super-high density record playback is attained. Furthermore, since-izing can be carried out [small lightweight] in this way, the inertial mass of optical head equipment becomes small, and high-speed tracking also becomes possible and becomes possible [shortening data-access time amount]. Furthermore, when an optical head forms small lightweight, it is possible to form the whole optical record regenerative-apparatus configuration into small lightweight, two or more record media and the optical record regenerative apparatus of the multi-platter mold which has two or more optical heads can be constituted, and a small and mass optical recording device can be obtained.

[Translation done.]

List of Information Disclosure Statement for a new patent application

(Our Ref.: NT1234US)

List of the prior art reference cited in the specification

1. Japanese Laid-Open Publication No.04-047512
2. Japanese Laid-Open Publication No.11-096608
3. International Publication No. WO 01/65547 A1

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